USE OF AN AQUEOUS SOLUTION IN THE TREATMENT OF LIVE ANIMALS

FIELD OF THE INVENTION

This invention relates to the use of an aqueous solution in the preparation of a medicament for use in the treatment of live animals. More particularly, the invention relates to a remedy for improving the growth performance of pigs and poultry, and to a method of treating pigs and poultry to enhance their growth performance.

BACKGROUND TO THE INVENTION

For the purposes of this specification, the term "animal" should be construed to include within its meaning sheep, cattle, goats, pigs, chickens, ostriches, reptiles and the like; the term "disease" should be construed to include within its meaning diarrhoea; the term "pathogen" should be construed to include within its meaning microorganisms such as E-coli; and the term "medicament" should be construed to include within its meaning oral bactericides and bactericidal inhalants. The applicant envisages that the invention will be applicable particularly, but not exclusively, in the preparation of a medicament for use in the treatment of pathogenic microorganisms in weaner piglets and chicklets.

It will be appreciated that in the commercial rearing of domestic livestock, notably in the pig and poultry industries, the growth performance of animals forms the basis of economic viability of an operation. A number of factors may influence such growth performance such as temperature, diet, stocking rates, general husbandry and notably the presence and level of harmful pathogenic microorganisms. The microorganisms may be abundant in the water, food and in air space in which the animals are housed. In general, all pathogenic microorganisms exert a deleterious effect on the animal to a

greater or lesser degree. This depends on factors such as the number of microorganisms present, the pathogenicity of the strain and its resistance to anti-microbials utilized in its control, as well as the immune status of an individual animal to a specific microorganism at any particular stage.

Methods such as antimicrobial medication of feeding rations, water treatment and inoculations are commonly employed to reduce the severity of impact on the animal. The efficacy of a chosen control measure, or combination of measures, is gauged in general by the percentage reduction in mortalities and the growth rate of survivors, taking into account the efficacy of growth (i.e. the amount of feed consumed per unit of growth). This is referred to as the feed conversion rate.

The current methods for the control of microorganisms is based on low level, and sometimes therapeutic, medication of feeding rations, as well as drinking water consumed by the animal. This practice has fallen out of favour in recent times due to the resistance being built up by microorganisms to antibiotics, as well as residue levels of such agents in meat consumed by people. The presence of antibiotic residues in food products leads to allergic and anaphylactic reactions in humans. The development of resistant strains of microorganisms makes anti-microbials ineffective. This method of disease control was recently banned in the European Union and other countries are following suit.

Object of the Invention

It is accordingly an object of the invention to provide inexpensive, novel and alternative antimicrobials that overcome the above disadvantages.

It is a further object of the present invention to provide a growth promoting remedy suitable for use in enhancing growth performance in animals, and in particular in pigs and poultry.

It is another object of the invention to provide a method of treating animals, and in particular pigs and poultry, to promote their growth over any fixed period of time.

It is a further object of the invention to disinfect contaminated water in animal production farms so that the water in effect becomes a disinfecting agent.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided a composition for treating live animals, and particularly pigs and poultry, characterised therein that it treats pathogenic microorganisms, while at the same time enhancing growth performance in the animals, the composition comprising an electrochemically activated aqueous solution including separable and both of an aqueous, mixed oxidant, predominantly anion-containing solution and an aqueous, mixed anti-oxidant, predominantly cation-containing solution, the electrochemically activated aqueous solution being characterised therein that it is produced by an electrochemical reactor including a through-flow, electrochemical cell having two co-axial cylindrical electrodes with a co-axial diaphragm between the electrodes so as to separate an annular inter-electrode space into a cathodic and an anodic chamber.

According to another aspect of the invention there is provided a method of treating live animals, and in particular pigs and poultry, so as to treat pathogenic microorganisms, while at the same time enhancing growth performance in the animals, the method comprising the steps of electrochemically activating an aqueous solution such that the solution includes separable and both of an aqueous, mixed oxidant, predominantly anion-containing solution and an aqueous, mixed anti-oxidant, predominantly cation-containing solution; separating the aqueous, mixed anti-oxidant, predominantly cation-containing solution from the aqueous, mixed oxidant, predominantly anion-containing solution; and introducing the aqueous, mixed anti-oxidant, predominantly cation-containing solution and the aqueous, mixed oxidant, predominantly anion-containing solution either simultaneously or sequentially into drinking water of the animal.

The anion-containing solution is referred to hereinafter for brevity as the "anolyte solution" or “anolyte” and the cation-containing solution is referred to hereinafter for brevity as the "catholyte solution" or “catholyte”.

The anolyte is introduced into the drinking water at between 5% and 20%, and preferably 15% by volume. The catholyte is used as the drinking water dosed at a rate equivalent to between 5 ml and 20 ml, and preferably an average of 10 ml per kilogram bodyweight of the animals to be treated.

It is well known that animals are also infected via the oral route by the ingestion of infected litter, harbouring very high counts of pathogenic microorganisms. These particular pathogenic microorganisms enter the oral cavity and migrate towards the small intestine over a period of time. The applicant has found that introducing the predominantly anion-containing solution into the drinking water destroys these pathogenic microorganisms. Such a method prevents the microorganisms from migrating to the small intestine. The applicant refers this to as the "pre-pyloric" method of control as opposed to the traditional post-pyloric method utilized when medicating with antibiotics in food or drinking water.

The applicant utilized a cylindrical electrolytic device, having at least one electrolytic cell, in which the anodic and cathodic chambers are separated by a permeable membrane and the specific design of which permits the harnessing of two distinct, separate and electrochemically different product streams of activated water, in a process known as electrolytic activation (EA) or electrochemical activation (ECA).

The design of the specific cell utilized by the applicant for this invention is such as to ensure a uniformly high voltage electrical field through which each micro-volume of water must pass. This electric field created in the cylindrical cell has a high potential gradient and results in the creation of solutions of which the pH, oxidation reduction potential (ORP) and other physico-chemical properties, lie outside of the range that can normally be achieved by conventional chemical or

most electrolytic means.

Two separate streams of activated solutions are produced, namely anolyte and catholyte. Depending on the production methods used and conditions of operation of the device, the anolyte typically can have a pH range of 1.5 to 9 and an oxidation-reduction potential (ORP) of +150 mV to +1200 mV. The anolyte is oxidizing, due to the presence of a mixture of oxidizing free radical ions, and has an antimicrobial effect. The catholyte typically can have a pH range of 8.5 to 13 and an ORP of about –150 mV to –900mV. The catholyte has reducing and surfactant properties and is an antioxidant. Through experimentation the applicant has found that for the treatment of live animals, the anolyte should have a pH range of between 5.3 and 8.0 and an oxidation-reduction potential (ORP) in excess of +750 mV, while the catholyte should have a pH range of between 8.5 and 11 and an ORP of less than –600 mV.

One of the advantages of the design of the specific cell utilized by the authors for this invention is that the chemical composition of the two solutions can be altered by utilizing various hydraulic flow arrangements, linking electrolytic cell modules in various configurations in order optimally to address the requirements of specific areas of application. Some other variables are flow rate, hydraulic pressure, concentration, temperature, current density, and voltage on the electrodes.

Aside from its distinctive attributes, the negatively charged anti-oxidant solution, i.e. the catholyte, can also be channeled back into the anode chamber, thereby modulating the quality of the positively charged oxidant solution, i.e. the anolyte that is produced. Depending on the specifications of the required application, variations in the design of the hydraulic systems can be effected to meet the requisite objectives.

The properties of electrolytically activated solutions are dependent upon a number of factors, including solution flow rate through the cell, type of salt used, voltage and current being applied, temperature, inter-flow dynamics of the solutions between the anode and cathode chambers, such as the degree of feedback of catholyte into the anolyte chamber, the design and geometry of the cell and the degree of mineralisation of the water.

It is important to note that the level of mineralisation of input water required to generate optimally formulated solutions is insignificantly different from the composition of potable water. However, the heightened electrical activity and altered physico-chemical attributes of the solutions differ significantly from the inactivated state, yet they remain non-toxic to animal tissue. Without maintenance of the activated state, these diverse products degrade to the relaxed state of benign water and the anomalous attributes of the activated solutions such as altered conductivity and surface tension similarly revert to pre-activation status.

The applicant believes that increased growth performance is achieved because of a reduction or elimination of pathogenic microorganisms present in water, food and in the environment surrounding the animal. The applicant has found that water medication at levels of as low as 0.1% anolyte reduces the presence of pathogenic microorganisms contained in it, thus reducing the risk of the animal becoming infected by this route.

The anion-containing aqueous solution may be prepared by means of electrolysis of an aqueous solution of a salt. The salt may be sodium chloride. In particular, it may be non-iodated sodium or potassium chloride, carbonates, bicarbonate, sulphate or phosphate, electrolysed to produce radical cation and radical anion species. These species may be labile and after about 96 hours, the various radical species may disappear with no residues being produced.

The anolyte solution may have a pH of between 5.3 and 7.5. The anolyte solution may include species such as ClO; ClO^-; $HClO$; OH^-; HO_2^-; H_2O_2; O_3; $S_2O_8^{2-}$ and $Cl_2O_6^{2-}$. These species have been found to have a synergistic anti-bacterial and/or anti-viral effect, which is generally stronger than that of chemical bactericides and has been found to be particularly effective against viral organisms and spore and cyst forming bacteria. The redox potential of the anolyte solution may be monitored during the process so that the treatment process may be monitored and controlled on a continuous basis.

The catholyte solution may include species such as NaOH; KOH; $CA(OH)_2$; Mg $(OH)_2$; HO^- ; $H_3O_2^-$; HO_2^- ; $H_2O_2^-$; O_2^- ; OH^-; O_2^{2-}.

The method of treatment may include administering the anolyte solution by soaking, rinsing or dipping the animal in the anolyte solution, or applying the anolyte solution as an inhalant via an atomising or fogging process. The soaking, rinsing or dipping process is suitable for animals that can be handled with relative ease.

The processes of atomising or fogging and oral administration by addition to drinking water are both suitable for animals such as weaner piglets and chicklets, which are susceptible to stress and accompanying weight loss. The atomising or fogging process may include the step of atomising the solution into the atmosphere in a volume to be treated, forming droplets of up to 100 micrometer. The method may include the preliminary step of enclosing the volume to be treated prior to atomising or fogging the enclosed volume.

The atomising or fogging process is preferably conducted at pre-determined intervals so as to maintain a suitable level of anolyte concentration in the atmosphere, thus utilising the optimum microcidal and other properties of the anolyte solution in accordance with the required administration rate.

The anolyte solution may also be applied by an atomising process in air ducting systems to destroy air-borne microorganisms and to destroy microorganisms present in the airways and lung tissue by inhalation.

The treatment of the animal as described above may be conducted so as to improve the weight gain as a result of the anti-microbial action of the anolyte solution.

The anolyte solution may have a specific anion concentration and distribution and a redox potential in accordance with the specific application.

The pathogenic microorganisms to be treated may include enteric pathogenic microorganisms and respiratory pathogenic microorganisms.

DETAILED DESCRIPTION OF THE INVENTION

A preferred embodiment of the invention will now be described with reference to the accompanying experiments.

In a series of experiments, the bactericidal effect of the anolyte solution was tested on animals. The results are reflected in the tables below.

The basic electrolytic cells used to generate the electrolytically activated solutions utilized in this invention are modular units with the operational

specifications for the reactors being optimised for each specific application. The cell includes a cylindrical metal vessel typically about 210 mm long and 16 mm in diameter, having a central rod anode (positive electrode) located within a concentric ceramic tube membrane. The outer tubular wall of the cell reactor acts as the cathode (negative electrode). Provision is made for inlet and outlet ports for the passage of the fluid through it.

Effectively, the ceramic membrane divides the cell into two compartments, the anode compartment and the cathode compartment. Water enters the cell and exits from these compartments as two streams, namely the anolyte and the catholyte, respectively. If so desired, some or all of the catholyte may be returned to the anode compartment so as to vary the properties of the anolyte being produced. Similarly, some or all of the anolyte may be returned to the cathode compartment so as to vary the properties of the catholyte being produced. A number of other hydraulic system configurations also exist, all of which are designed to achieve specific objectives.

The design of the cell is such as to ensure a very high uniform electric field through which each micro volume of water must pass. In so doing the molecules of water in the anolyte and catholyte acquire special properties which cannot be reproduced by other (more conventional chemical) means. This electrolytic treatment results in the creation of anolyte and catholyte solutions whose pH,

oxidation-reduction potentials (ORP) and other physico-chemical properties lie outside of the range that can be achieved by conventional chemical means.

In this invention the pH, ORP and concentration values of chlorine, chlorides and other dissolved salts have been determined, unless otherwise stated, as per standard methods of examination of water and effluents.

Experiment 1 - Weaner Piglets

The anolyte solution was added to the drinking water of the weaner piglets over a period of 14 days and the results were measured in terms of average weight after the 14 day period. The average weight of the administered groups were compared with the average weight of the non-administered groups.

The administered groups showed relative weight gain relative to the non-administered groups. The relative weight gains of the administered groups are reflected in Table 1 below.

Experiment 2 - Broilers (Chicklets)

Day old broilers were administered with anolyte solution (10% diluted) by addition to drinking water for 7 days. (Group C3 - 12 000 chicklets). No antibiotic medication was administered during that time. Untreated control groups (C1, C2, C4 and C5 = total 48 000 chicklets) received normal drinking water during that

time. The untreated groups were routinely medicated with Tylosin for 3 consecutive days.

Bacterial analyses of the drinking water of all groups were regularly conducted during the first 7 days. Other measurements included daily mortalities and morbidities throughout and pH and ORP determinations of the drinking water during the first 7 days. All results are reflected in Table 2 below.

Medication of drinking water with anolyte solution supplied to day-old chicklets for the first period resulted in a significant reduction in mortalities throughout the growth and finishing period. Mortalities increased in all the groups from the 4th week onwards mainly due to respiratory disease. It is envisaged that these could be reduced by fogging the environment with anolyte solution to eliminate airborne respiratory pathogens by means of respiratory intake.

It has been found that the efficacy of the use of the anolyte solution in the treatment of live animals depends upon the concentration of the anions in the anolyte solution, as measured by the oxidation-reduction potential (ORP) or redox potential of the anolyte solution, the flow rate through the reactor, the exposure time, i.e. the contact time between the contaminated animal and the anolyte solution and the temperature during application. By measuring the redox potential of the anolyte solution during the treatment, for example, of a weaner piglet, the

available free radical concentration can be monitored. Anolyte solution has been found to be more effective at lower than at higher temperatures.

Example 3 - Broilers (Chicklets)

The applicant has found that growth rates in broiler chickens were significantly enhanced when the water source was treated with anolyte when compared to an untreated control group. The trial consisted of one control group and six treatment groups, each with three replicates of 50 chickens. All replicates were randomly assigned a trial enclosure within the same house, and all chickens were hatched on the same day from the same parent flock. Weight recordings were conducted every second week on the total group and on alternate weeks on individual chickens. All mortalities were recorded. Feed and water was supplied ad libitum and feed intake per replicate accurately recorded. The following treatments were applied:

Control group	Received no medication in water
Oxine	water medication for 42 days
Chemsol	water medication for 42 days
Anolyte (10%)	water medication for 42 days
Anolyte (15%)	water medication for 12 days
Anolyte (20%)	water medication for 12 days

Chickens were slaughtered at 42 days, at which time final live weights and food intake over the period recorded.

The following table summarizes the results (i.e. weight in grams):

MEDICATION	DAY 0	DAY 7	DAY 14	DAY 21	DAY 28	DAY 35	DAY 42
Control	39.0	90.6	129.7	441.2	795.2	1284.7	1903.4
Oxine	39.3	94.7	200.3	461.7	815.5	1346.2	1955.9
Chematron	40.7	118.0	259.2	571.0	960.0	1495.2	2119.0
10% Anolyte	40.0	126.9	278.0	603.4	1031.8	1592.6	2227.8
15% Anolyte	40.0	130.7	294.8	631.3	1061.6	1650.7	2283.3
20% Anolyte	40.0	125.3	283.7	579.9	1006.0	1572.3	2106.8

Example 4 - Broilers (Chicklets)

Production parameters (as measured by mortality reduction, final slaughter mass, kilogram meat produced per m^2 floor space and feed conversion rates) in the following example were significantly enhanced. In this trial the above parameters obtained on the same site in 2 previous cycles (i.e. 110 and 111) were compared to the experimental one (i.e. 112) where broiler chickens were again treated with anolyte. The site consisted of 6 broiler houses each stocked with 27 00 broilers.

CYCLE NO	AVE FLOCK AGE	MORTALITY %	AVE AGE	AVE MASS (KG)	KG/M² PER HOUSE	FEED CONVERSION RATE
110	37.1	6.01	39.5	1.805	30.97	1.88
111	37.1	9.09	39.0	1.741	29.23	1.92
112	36.6	5.25	40.9	2.006	35.07	1.86

It is evident from the above results that when the anionic solution was dosed into the drinking water at an inclusion rate of 15%, fewer chickens died, the live mass was significantly higher whilst converting food more efficiently. In this trial approximately 5 kg live mass per square meter floor space, equating to 7.35 tonnes per house or 44.1 tonnes per site additional meat, was produced. No antibiotic water medication was employed in cycle 112 whilst in both preceding cycles FOSBAC (fosamycin 20% and tylosin 5%) was used.

<u>Example 5 – Weaner Piglets</u>

In this trial the effect of the addition of anolyte on the productivity of weaners was studied. The trial was carried out over two rounds with a total of 16 replicates per round and 400 pigs per group. Microbial examinations of drinking water showed the total number of bacteria to be reduced from 3 500 000/ml to zero and of Coliforms from >160/ml to zero when either 25% or 10% anolyte was added. Mortalities and clinical cases showed no difference between treatment and control groups.

The following table summarizes results:

GROUP	CONTROL	ANOLYTE
Number of pens	16	16
Number of pigs penned	408	408
Daily gain (g) – first 2 weeks post weaning	116	141
Daily feed intake – first 2 weeks post weaning (kg)	0.22	0.24
Feed conversion (kg feed/kg gain)	1.94	1.72

It will be appreciated that many variations in detail are possible without departing from the scope and/or spirit of the invention as set out in the claims hereinafter.